Modeling the Linkages between Climate Change, Food Security, and Population

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Background

A growing body of evidence indicates that climate change is decreasing the productivity of many crops around the world, thus exacerbating existing food security challenges. Ensuring sufficient food for a growing world population in the context of climate change will require innovative technologies and strategies to boost agricultural yields and improve access to nutritious foods for the world's poorest people. This research demonstrates that slower population growth, achievable by addressing women's existing needs for family planning, can also play a significant role in promoting future food security in a climate-altered world.

We combined three models to explore the linkages between climate change, food security and population and tested it using data from Ethiopia. The results demonstrate that lowering fertility rates that would result from greater use of family planning would help to promote food security in two important ways: by slowing population growth, thereby easing demand on strained agricultural systems; and by altering population composition in ways that can enable improved nutritional outcomes among children under five—a group that is highly vulnerable to food insecurity. The results suggest that meeting women's existing needs for family planning should be considered in broader strategies for adapting to the impacts of climate change on agriculture.

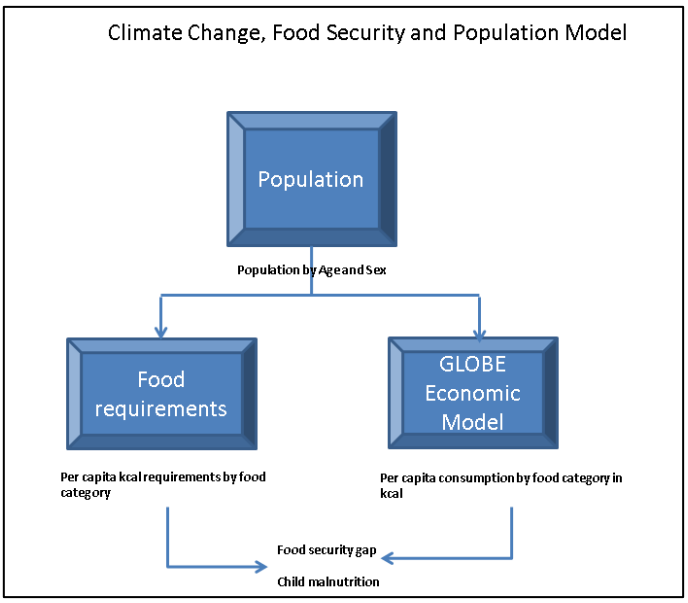
Methodology

Rising global temperatures and shifting precipitation patterns are among the effects of climate change that have already been observed as a result of increased concentrations of greenhouse gases in the atmosphere.[1] These changes are expected to reduce agricultural productivity in many countries where high proportions of the population rely on rain-fed agriculture, thus increasing the risk of food shortages. It is estimated, for example, that due to climate change, maize yields in Africa may be 22% to 35% lower by 2030 than would otherwise occur[2] (see Figure 1).

At the most basic level, ensuring food security requires securing sufficient food for a given population. There are many factors that affect food security, including food prices, trade, aid, poverty, distribution and access, and the nutritional content of food. The model constructed for this study examined how climate change is likely to affect food supply in a given country over time, and how different population projections will affect the total and per capita calorie requirements of a country's population. Using this model to better understand these foundational aspects of future food supply and demand can help to inform effective, holistic strategies to improve food security.

In carrying out this analysis, we examined how different population growth scenarios would interact with future food requirements and food consumption in Ethiopia given the projected impacts of climate change on agricultural production. As can be seen in Figure 1, we combined three

Figure 1



models: 1) a demographic model to project population growth,[3] 2) a food requirements model to project calorie requirements necessary to maintain the health of the population,[4] and 3) an economic model to project food consumption based on a number of factors, including the effects of climate change on agricultural yields.[5]

We modeled two scenarios of population growth: a "medium fertility" scenario in which fertility in Ethiopia declines slowly, from an average of 4.8 children per woman today to 2.3 children per woman in 2050; and a "low fertility" scenario, in which fertility declines to 1.8. Such fertility declines are feasible, given that currently, 25% of married women in Ethiopia report that they either want no more children or want to wait two years before having another child, but are not using contraception.[6] The fertility declines of both scenarios would require expanded access to and use of family planning services throughout Ethiopia.

Key Findings

Using FAO methodology for estimating human energy requirements, we estimated that the average daily per capita calorie requirement needed to maintain the health of the population in Ethiopia is approximately 2,200. Currently, 60% of the Ethiopian population consumes fewer calories than this daily physiological requirement;[7] the average daily per capita calorie consumption is about 1,980 – a shortfall of about 220 calories per day, or 20% on average.

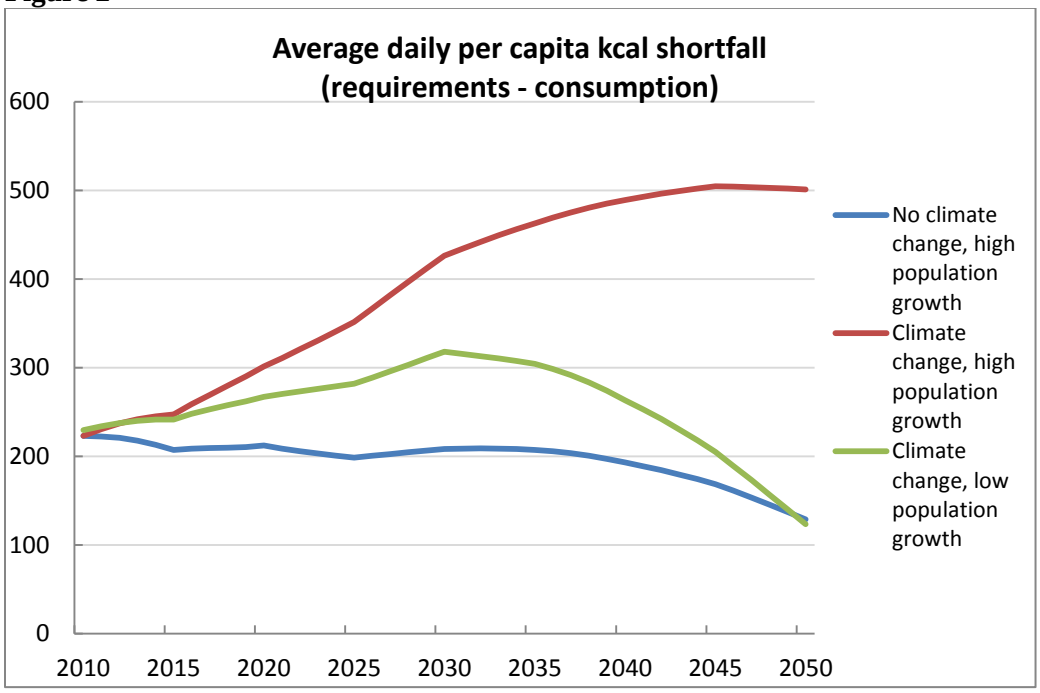
In projecting how food production and consumption may change in the future, we used a model that incorporates Ethiopian and international economic data about the production and trade of foodstuffs and other commodities, as well as their prices. In a scenario in which there is assumed to be no climate change and therefore no effect on agricultural yields, the average per capita calorie consumption in Ethiopia would increase slightly by 2050 due to projected development gains, though still fall short of estimated food requirements.

However, in a scenario that accounts for climate change and its impacts on the agriculture sector, average per capita calorie consumption would decrease dramatically, resulting in an average shortfall of more than 500 calories per day by 2050 (see Figure 2).

Each of the above scenarios incorporates the "medium fertility" population growth scenario that assumes continued modest declines in fertility. However, when the "low fertility" population growth assumption is used, the caloric shortfall shifts significantly. In a scenario in which climate change affects agriculture, a low fertility population growth assumption reduces the average per capita shortfall in Ethiopia in 2050 from more than 500 calories per day to 127 calories per day (see Figure 2). This reduced shortfall is equivalent to the shortfall in the medium fertility scenario *without climate change*, meaning that a lower

fertility scenario has the potential to fully compensate for the projected impact of climate change on food consumption.

Figure 2



In addition to reducing fertility to levels consistent with the low fertility population growth scenario, addressing existing needs for family planning in Ethiopia would have other benefits for the health and well-being of women, children, and families. Because of these benefits, expanding access to and use of family planning is already a component of Ethiopia's development strategy.[8]

The fertility declines of the low fertility scenario would also result in changes in population composition. Lower fertility will result in fewer children less than five years of age. In many countries, this age group is particularly vulnerable to malnutrition and food insecurity; in Ethiopia, for example, almost 30% of children under 5 are underweight.[9]

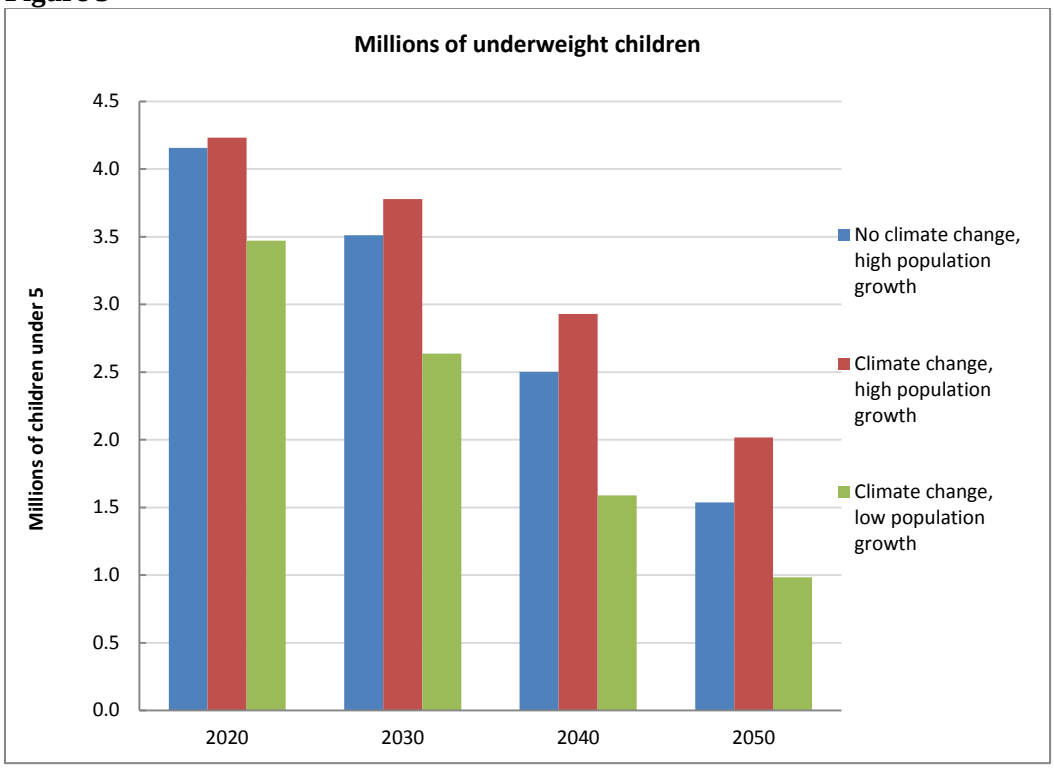
The model shows that with the projected development advances under the policy scenarios will result in fewer malnourished children by 2050, but climate change is expected to confound progress in reducing childhood malnutrition. In a low fertility population growth scenario, the number of malnourished children would be dramatically lower by 2050, due to a smaller overall cohort of children under five and greater per capita food consumption (see Figure 3).

Conclusion

The world's changing climate will affect the agricultural sector in ways that will compound the challenge of achieving food security in many parts of the world, especially in sub-Saharan Africa. As temperatures rise and precipitation patterns become more erratic, strategies to adapt to these changes and boost agricultural yields are needed. The scale and scope of the food security challenge, however, warrants consideration of a broader set of strategies that relate to both future food supply and demand. The analysis summarized in this paper is among the first to quantitatively demonstrate the benefits that reducing

population growth through family planning can contribute to improving food security in the context of climate change.

Figure 3



Meeting women's needs for family planning has long been recognized as an important development goal because of the many benefits that result: healthier women, healthier children, and greater prospects for education and poverty alleviation. Results of this analysis indicate that in Ethiopia—a country with high fertility, high unmet need for family planning, and vulnerability to food insecurity due to climate change—investing in meeting women's needs for family planning would reduce fertility in ways that can significantly improve prospects for future food security.

The conditions facing Ethiopia are shared by many countries throughout the developing world. This analysis suggests that family planning interventions should be incorporated into national and international strategies and plans for climate change adaptation and food security. Decision-makers, planners, and funders concerned with climate change adaptation and food security should evaluate population growth and fertility trends, and consider family planning as a potential climate change adaptation strategy.

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[1] Intergovernmental Panel on Climate Change, *Climate Change 2007: Synthesis Report Summary for Policymakers*.
[2] Bailey, Robert, "Growing a Better Future: Food Justice in a Resource-Constrained World," Figure 11, Oxfam International, June 2011.
[3] The DemProj sub-model of Spectrum, details available at http://futuresinstitute.org/pages/spectrum.aspx
[4] Based on Food and Agriculture Organization of the United Nations. 2004. *Human energy requirements: Report of a Joint, FAO/WHO/UNU Expert Consultation, Rome, 17–24 October 2001*.

[5] GLOBE model runs provided by the Institute of Development Studies at the University of Sussex, based on McDonald, S., Thierfelder, K., Robinson, S. (2007) Globe: A SAM Based Global CGE Model using GTAP Data. *USNA Working Paper* 14. US Naval Academy: Annapolis.

[6] *Ethiopia Demographic and Health Survey 2011: Preliminary Report*, Central Statistical Agency, Addis Ababa, Ethiopia; and MEASURE DHS, ICF Macro, Calverton, Maryland, USA.

[7] Authors' calculations based on IFPRI 2009 Ethiopia Rural Household Survey data

[8] *Growth and Transformation Plan, 2010/11-2014/15*, Federal Democratic Republic of Ethiopia, Ministry of Finance and Economic Development, Addis Ababa.

[9] *Ethiopia Demographic and Health Survey 2011: Preliminary Report*, Central Statistical Agency, Addis Ababa, Ethiopia; and MEASURE DHS, ICF Macro, Calverton, Maryland, USA.